APPENDIX A – SUPPLEMENTAL INFORMATION FOR SELECTION OF PRGS

EAST WATERWAY OPERABLE UNIT FEASIBILITY STUDY

Prepared for

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PART 1: COMPLIANCE WITH SEDIMENT MANAGEMENT STANDARDS

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1 INTRODUCTION

The Feasibility Study (FS) for the East Waterway (EW) Operable Unit (OU) has been developed under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Consistent with CERCLA requirements, the selected alternative must substantively comply with applicable or relevant and appropriate requirements (ARARs), which include portions of the Washington State Sediment Management Standards (SMS). The SMS are the Washington State standards for remediating sediments under the Model Toxics Control Act (MTCA). This appendix provides a brief description of ~~describes~~ the methods and procedures for establishing cleanup levels under the SMS, and also discusses how the ~~selected~~ EW alternatives developed under CERCLA will comply with the SMS requirements.

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The preliminary remediation goals (PRGs) presented in Section 4 of the FS were developed to comply with portions of the SMS ~~as an~~that are ARARs under CERCLA, including the determination of cleanup levels[1] under Washington Administrative Code (WAC) 173-204-560. The SMS cleanup level determination is performed by determining the sediment cleanup objectives (SCO; discussed in Section 2 of this appendix) and the cleanup screening levels (CSL; discussed in Section 3 of this appendix). The cleanup levels are initially set at the SCO. If the SCO is not technically possible to attain, or would result in net adverse environmental impacts, then the cleanup level can be adjusted up to the CSL.

For several contaminants of concern (COCs) in the FS, the SCO-based PRG has been established at the natural background concentration ~~or practical quantitation levels (PQLs)~~, because risk-based SCO concentrations are lower than the natural background concentration~~,~~. ~~but the~~ This is consistent with both SMS and CERCLA. Although both SMS and CERCLA allow for a regional background-based CSL value to be considered as well, there is no EPA-approved regional background concentration ~~A regional background-based CSL has not been established because regional background has not been~~ determined for the EW area. ~~In the absence of regional background values, cleanup levels (i.e., PRGs) for these~~

[1] For the purpose of this appendix only, ~~T~~the SMS term "cleanup level" is considered analogous to the CERCLA term "PRG" used in the main text of the FS. This appendix sometimes uses the term "cleanup level" for consistency with the SMS. In other contexts, these terms may not have the same meaning.

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~~COCs are based on the SCO in the EW FS. For some of these COCs, the SCO is not technically possible to achieve.~~ As described in Section~~s 2, 3, and~~ 4, FS model predictions developed by the Port of Seattle (Port) indicate long-term post-cleanup concentrations of total polychlorinated biphenyls (PCBs) and dioxins/furans that are higher than the ~~currently have cleanup levels based on unattainable~~ natural background~~ or PQL~~-based PRGs ~~concentrations based on the best-estimate predictions of sediment concentrations in the FS~~ (e.g., see FS Section 9).[2,3]

Based on preliminary evaluations, the EW OU cleanup is expected to comply with MTCA/SMS for protectiveness of human health for direct contact (remedial action objective [RAO] 2), protection of the benthic community (RAO 3), and protection of higher trophic level organisms (RAO 4) by achieving the PRGs for these RAOs. Following source control and remediation efforts, surface sediments in the EW OU are not currently predicted under the Port's model to attain all natural background-~~-or PQL~~-based PRGs for protection of human health for seafood consumption (RAO 1). This is based on ~~, due to~~ estimates of the ongoing contribution of elevated concentrations from diffuse, nonpoint sources of contamination that contribute to regional background concentrations. However, achieving the MTCA/SMS ARARs may occur in one of two ways:

- Post-remedy monitoring may demonstrate sediment concentrations lower than currently predicted by the models, and PRGs identified in this FS may be attained for certain chemicals in a reasonable restoration timeframe. If necessary, the restoration timeframe needed to meet the PRGs could be extended ~~beyond 10 years~~by the United States Environmental Protection Agency (EPA) if consistent with CERCLA. ~~and~~In making such a determination, EPA may take into account the substantive ~~requirements~~criteria for ~~of~~ a Sediment Recovery Zone (SRZ) as ~~defined~~provided by the SMS at WAC 173-204-590(3) (see Section 5 of this appendix).
- Sediment cleanup levels (SCLs) may be adjusted upward ~~once~~if regional background levels are established for the geographic area of the EW (see Section 4 of this

[2] Note that none of the alternatives is predicted by the Port's FS models to achieve the SCO for these chemicals; therefore, this appendix applies equally to any of the alternatives, if selected.
[3] Note that the Port's FS models are based upon estimated values for contaminant inputs and removal and do not include decreases in inputs due to source control. Uncertainties associated with the model are discussed in Appendix I.

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appendix), and EPA determines these levels are appropriate for use at the EW CERCLA site. Considering that a regional background value has not yet been determined for the EW, such adjustments could occur in the Record of Decision (ROD) (before remediation) or subsequently as part of a ROD amendment or Explanation of Significant Differences (ESD) (during or after remediation). Consistent with the bullet above, the restoration timeframe needed to meet the SCLs could be extended ~~beyond 10 years~~by EPA if consistent with CERCLA requirements for a reasonable restoration timeframe ~~and the substantive requirements of an SRZ as defined by SMS~~.

In addition, following remediation and long-term monitoring, if ~~the U.S. Environmental Protection Agency (~~EPA~~)~~ determines that no additional practicable actions can be implemented under CERCLA to meet certain MTCA/SMS ARARs, EPA may issue a ROD Amendment or ESD providing the basis for a technical impracticability (TI) waiver for specified MTCA/SMS ARARs under Section 121(d)(4)(C) of CERCLA, 42 U.S.C. § 9621(d)(4)(C).

Because it is not known whether, or to what extent, the SMS ARARs for total PCBs and dioxin/furans will be achieved in the long term, ~~or the timing of a potential regional background evaluation~~, it is not possible at this time to determine with certainty whether the FS alternatives will attain the SMS ~~compliance mechanism is not selected at this time~~ARARs. The rest of this appendix provides additional detail regarding establishing SCO (Section 2) and CSL (Section 3), potentially upwardly adjusting cleanup levels in the future (Section 4), and implementation of an SRZ (Section 5). Section 6 provides a summary of the methods to that may be used to comply with the SMS ARARs.

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2 SEDIMENT CLEANUP OBJECTIVES

The SMS outline procedures for establishing the lower bound for cleanup levels, called the SCO. Multiple exposure pathways, natural background concentrations, and PQLs are all considered when determining the SCO, as follows:

> *WAC 173-204-560 (3) Sediment cleanup objectives. The sediment cleanup objective for a contaminant shall be established as the highest of the following levels:*
>
> *(a) The lowest of the following risk-based levels:*
>
> *(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(2);*
>
> *(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;*
>
> *(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and*
>
> *(iv) Requirements in other applicable laws;*
>
> *(b) Natural background; and*
>
> *(c) Practical quantitation limit.*

As summarized in Tables 4-43 and 4-54 of the FS, RAOs were established under CERCLA for this FS to be consistent with WAC regulations:

- Risk-based threshold concentrations (RBTCs) associated with RAOs 1 and 2 were established to be consistent with WAC 173-204-560(3)(a)(i)
- RBTCs associated with RAO 3 were established to be consistent with WAC 173-204-560(3)(a)(ii)
- RBTCs associated with RAO 4 were established to be consistent with WAC 173-204-560(3)(a)(iii)
- ~~Natural background concentrations were established to be consistent with WAC 173-340-709~~
- ~~PQLs were established to be consistent with WAC 173-204-505(14)~~

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Commented [A1]: WAC 173-340-709 (Methods for defining background concentrations under MTCA) is not considered by EPA to be an ARAR and is not used by EPA for establishing background.

Commented [A2]: This definition of practical quantitation limit under the SMS mentions use of "department [of Ecology] approved methods" EPA determines the appropriate analytical methods and detection levels at CERCLA sites.

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~~Based on WAC 173-204-560(3) and values from t~~The Washington State Department of Ecology (Ecology) Sediment Cleanup User's Manual (SCUM) II (Ecology 2017) is not an ARAR under CERCLA, although some portions of SCUM II may be "to be considered" (TBC). As discussed in Section 4 of the main body of the FS, EPA has prescribed other methods for determining natural background concentrations for establishing PRGs in compliance with CERCLA (e.g., see FS Table 4-2). Solely for informational and comparison purposes, it is noted that in SCUM II~~,~~ the SCO ~~would be established~~ based on natural background for total PCBs is listed as ~~(~~3.5 micrograms per kilogram [µg/kg] dry weight [dw]~~)~~ and the PQL for dioxins/furans is ~~(~~5 nanograms [ng] toxic equivalent [TEQ]/kg dw), because these are the highest of the three SCO levels for these compounds. The arsenic SCO is also established at natural background, but the Ecology-determined natural background concentration of 11 milligrams per kilogram (mg/kg) would be~~is~~ achievable based on best-estimate FS model results ~~and, therefore, the establishment of a CSL value is not required~~. However, EPA does not consider these values ARARs or TBCs. ~~As discussed in Section 4 of the main body of the FS, EPA has prescribed other methods for determining natural background concentrations for establishing PRGs in compliance with CERCLA (e.g., see FS Table 4-2).~~

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3 CLEANUP SCREENING LEVELS

The SMS outline similar procedures for establishing the upper bound for cleanup levels, called the CSL:

WAC 173-204-560 (4) Cleanup screening levels. The cleanup screening level for a contaminant shall be established as the highest of the following levels:

(a) The lowest of the following risk-based levels:

(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(3);

(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;

(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and

(iv) Requirements in other applicable laws;

(b) Regional background as defined in subsection (5) of this section; and

(c) Practical quantitation limit.

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RBTCs associated with the CSL (excess cancer risk of 10^{-5} or hazard quotient of 1) are presented in FS Table 3-13 and are well below the SCOs for total PCBs and dioxins/furans. The SMS defines regional background as follows:

WAC 173-204-505(16)

Regional background means the concentration of a contaminant within a department-defined geographic area that is primarily attributable to diffuse nonpoint sources, such as atmospheric deposition or storm water, not attributable to a specific source or release. See WAC 173-204-560(5) for the procedures and requirements for establishing regional background.

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~~The CSL for total PCBs and dioxins/furans may be based on regional background concentrations, once established. However, i~~In the absence of regional background concentrations deemed by EPA to be suitable for use at the EW CERCLA site, and because

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the risk-based levels are below the SCO, the CSL has not been established for total PCBs or dioxin/furans.

In the future, Ecology may~~is currently~~ developing an approach to collect additional information to establish regional background for the Lower Duwamish Waterway (LDW), but~~and~~ has not yet ~~determined~~suggested how this ~~will~~may be applied to the EW. EPA may consider this approach and information once they have been provided by Ecology.

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4 ADJUSTMENT OF CLEANUP LEVELS

~~Because regional background concentrations have not been determined for the EW and the upper bound for the cleanup level (the CSL) has not been determined, t~~As discussed previously, the cleanup levels in the FS are set at the SCO for total PCBs and dioxins/furans. However, if regional background concentrations suitable for use at the EW OU are established, then, following the SMS, the cleanup levels may~~will~~ be adjusted upward by EPA based on the following site-specific factors:

> *WAC 173-204-560(2)(a)*
> *(ii) Upward adjustments. The sediment cleanup level may be adjusted upward from the sediment cleanup objective based on the following site-specific factors:*
> *(A) Whether it is technically possible to achieve the sediment cleanup level at the applicable point of compliance within the site or sediment cleanup unit; and*
> *(B) Whether meeting the sediment cleanup level will have a net adverse environmental impact on the aquatic environment, taking into account the short- and long-term positive effects on natural resources, habitat restoration, and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions*

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The following sections discuss the site-specific factors that could be considered by EPA to adjust the cleanup levels from the SCO.

4.1 Technical Possibility

The technical possibility is defined in the SMS as follows:

> *WAC 173-204-505(23)*
> *"Technically possible" means capable of being designed, constructed and implemented in a reliable and effective manner, regardless of cost.*

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~~Ecology guidance, provided in the SCUM II (Ecology 2017), further clarifies WAC 173-204-560(2)(a)(ii)(A) that adjustment of the cleanup level upward should be based on "whether it~~

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~~is technically possible to achieve *and maintain* the cleanup level at the applicable point of compliance." [emphasis added]~~

Commented [A3]: Although we don't disagree that maintenance of the CUL should be considered in a "technical possibility" determination; this provision in SCUM II is not an ARAR.

This section first estimates the lowest technically possible concentrations that could be achieved in the EW immediately following construction for a hypothetical maximum remediation scenario. It also evaluates what is technically possible to maintain in the long term following construction. The combination of these two evaluations ~~is~~by the Port may be used by EPA to evaluate technical possibility. This analysis is developed for FS purposes only; it contains numerous assumptions about future conditions that cannot be reliably estimated at this time. It is an evaluation by the Port that is not required to be used for decision-making by EPA, including establishing PRGs or cleanup levels. ~~t~~Technical possibility will be determined based on empirical long-term monitoring data for the selected alternative to comply with the SMS.

4.1.1 Technical Possibility of Maximum Remediation Scenario

The EW is a highly urbanized, commercial waterway with actively used marine transportation infrastructure along most of the shoreline area that limit the remedial activities that can occur. For example, full removal of all contaminated sediment near structures is not possible without affecting ~~because full removal would affect~~ structural stability. As a result, some amount of undisturbed contaminated sediment will in all likelihood remain in ~~surface sediments~~ near structures following remediation, however, measures to minimize releases from these areas will be considered in the design phase.

This section describes an FS~~design~~-level analysis on a hypothetical site-wide dredging scenario to estimate the lowest concentration that ~~would~~may be technically possible to achieve for total PCBs at the completion of construction. The scenario was developed by the Port assuming that all engineered infrastructure such as piers, engineered embankments, keyways, bridges, and the communication cable crossing would remain in place. EPA reviewed some but not all of the input parameters and assumptions used in this model. Removing and reconstructing the infrastructure associated with the EW would require massive modifications (e.g., reconstructing the West Seattle Bridge, temporarily closing important Coast Guard and Port of Seattle terminals, etc.) that would result in excessive disturbance to essential public and private infrastructure. Moreover, this scenario assumed

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that remediation would be performed by dredging everywhere possible and included residuals management re-dredging passes where practicable to further lower concentrations. Dredging was assumed to be followed by residuals management cover (RMC) in most locations, and was assumed to be followed by in situ treatment with activated carbon in underpier and keyway areas where RMC material could not be placed due to stability concerns and navigation depth requirements. Note that this hypothetical scenario was created for ~~developed for this analysis only~~the purposes of developing and bounding alternatives in support of the FS and does not itself represent an alternative in the FS nor is it intended to make definitive statements regarding future concentrations in the EW. Also note that this analysis estimates concentrations at a single point in time (immediately after construction)—ignoring ongoing mixing, propwash, ~~and~~ incoming sedimentation, and the decreased loading associated with future source control efforts within the upper Duwamish and Green River watersheds. These estimates introduce uncertainties in the results and may introduce bias compared to what can be accomplished in the long-term ~~—and is therefore considered by the Port to be biased low compared to what can be achieved in the long term~~ (Section 4.1.2).

To support this analysis, the EW was divided into six areas based on the physical constraints of each (Table 1, Figure 1).~~,~~ S~~and s~~patially-weighted average concentrations (SWACs) immediately following construction were calculated ~~from~~using the box model evaluation for each as summarized in the following paragraphs. It should be noted two key parameters which have a large influence on model outputs are likely biased high: potential future reductions in bioavailable concentrations of PCBs after in-situ treatment are likely to be higher than estimated in the model, and estimates of incoming sediment concentrations do not account for upstream source control.

Area 1

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The first area consists of most of the open-water areas of the waterway (114 acres), and has the fewest structural limitations affecting remediation. In these areas, the assumed remediation scenario was dredging the waterway to the deepest extent of contaminated sediment, followed by two residuals management re-dredging passes (average of 2 feet removal for each), followed by RMC placement. The resulting concentration immediately following construction in surface sediment (top 10 centimeters [cm]) was estimated to be

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10 µg/kg dw for total PCBs for this area, based on the dredging residuals calculation methodology presented in FS Appendix B, Part 3A.

Area 2

The second area includes 15 acres of underpier sediments that have limited access and are present on top of slopes comprised of large riprap (see Figure 2). Remediation in these areas is challenging due to access limitations and the presence of hard riprap surfaces and rock interstices. These areas were assumed to be dredged by diver-assisted hydraulic dredging, followed by a thin placement of in situ treatment material to reduce bioavailability of the remaining sediment. The resulting post-construction concentration was estimated to be 290 µg/kg dw for total PCBs. This assumed that an average of 10 cm (3.9 inches) of sediments would remain in place following remediation due to the difficulty of full removal on riprap slopes and within rock interstices, followed by the mixing of 7.6 cm (3 inches) of in situ treatment material (see residuals calculations presented in FS Appendix B, Part 3A). In situ treatment material was also assumed to reduce the bioavailability of hydrophobic organic compounds such as PCBs by 70%, resulting in an estimated effective bioavailable underpier average concentration estimated on a dry-weight basis of 153 µg/kg[4]. Note that in situ treatment is a less proven technology than the others presented in this evaluation and, therefore, in situ treatment is used only in areas where other, more-proven technologies are not feasible or unlikely to be effective, such as under the piers (see Section 7.2.7.1 and 7.8 of the FS). ~~R~~The assumed reduction in bioavailability of 70% is approximated from available evidence from bench-scale laboratory studies and field demonstrations and is a conservative (low) estimate considering that these studies have consistently shown reductions of 90% to 99%~~, and is subject to uncertainty~~.

Area 3

The third area includes 7 acres of keyways that are at the base of the underpier slopes (see Figures 1 and 2). These are rock structures keyed into the toe of the riprap slopes to maintain the stability of the slopes above. The tops of the keyways are situated at the navigation depth of approximately -51 feet mean lower low water, therefore limiting the amount of removal

[4] Note the dry-weight concentration is intended to estimate bioavailability reduction to support calculation of a site-wide SWAC that considers the benefits of the application of in situ treatment material, but this concentration is not what would be measured on a dry-weight basis following construction.

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and the amount of clean fill placement that can be performed in these areas. Similar to the underpier areas, these areas were assumed to be dredged to the maximum extent possible without removing riprap, followed by a thin placement of in situ treatment material to reduce bioavailability. For this analysis, dredging was assumed to be performed by standard mechanical means. The resulting post-construction concentration was estimated to be 364 µg/kg dw for total PCBs based on an average of 10 cm (3.9 inches) of sediment remaining following dredging, with a 7.6-cm (3-inch) layer of clean in situ treatment material being placed following dredging. The effective bioavailable average concentration in keyways (using a 70% reduction in dry weight concentrations) was estimated to be 192 µg/kg. ~~Note that the placement of in situ treatment material in keyways presented for this evaluation is hypothetical to support this evaluation; however, some keyway areas are already at the required navigation elevation and placement would not be possible in some areas due to navigation requirements. In addition~~Note that~~,~~ long-term effectiveness and stability of placement near active berthing areas is highly uncertain because of propeller wash (propwash), but was assumed to be stable for the purpose of this analysis.

Commented [A4]: EPA disagrees that AC placement of 3 inches would impact ship navigation.

Area 4

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The fourth area includes 18 acres of structural slope and offset areas where dredge depths will be limited by the geotechnical stability of adjacent slopes (see Figures 1 and 2). In these areas, some contaminated sediment will be left behind; however, these elevation constraints are assumed to still allow the placement of a full RMC layer (i.e., average 9-inch-thick sand layer). The concentration immediately following completion of construction was estimated to be 35 µg/kg dw for total PCBs based on the dredging residuals methodology presented in Appendix B, Part 3A, of the FS.

Area 5

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The fifth area includes 2.4 acres under the West Seattle Bridge and the bridge at the head of Slip 27 that have access restrictions (Figure 1). In these areas, removal is limited by geotechnical and structural considerations required to maintain stability of bridge columns. However, these areas are not limited in the amount of clean cover that could be placed following dredging. In addition, these areas experience little to no sediment disturbance from propwash. The resulting post-construction concentration was estimated to be 10 µg/kg dw for total PCBs through limited removal and RMC placement.

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Area 6

The sixth area includes 1.8 acres under the three low bridges in the Sill Reach (Figure 1). These areas are characterized by extreme access limitations and widespread debris. Diver-assisted hydraulic dredging would be ineffective in these areas due to the presence of debris. Therefore, enhanced natural recovery (ENR) was assumed in these areas, with a post-construction concentration of 8 µg/kg dw, as a result of some dredging residuals depositing from adjacent areas consistent with the conceptual site model of sediment transport in the EW.

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~~This analysis demonstrated that it is not technically possible to achieve the natural background-based SCO for total PCBs.~~ Based on the Port's analysis, ~~C~~considering all of these areas together, the site-wide SWAC immediately following construction was estimated to be 57 µg/kg dw for total PCBs, with an effective bioavailable concentration of 34 µg/kg. ~~Note that this post-construction SWAC is the theoretical limit of technical possibility.~~ This analysis by the Port indicates, based on the assumptions (not all of which have been reviewed by EPA) and projections made and inputs considered, that the natural background-based SCO for total PCBs would not be achieved. As discussed above, there is a large amount of uncertainty associated with the estimated values for each area. In addition~~As discussed above~~, this hypothetical SWAC assumes that construction would be completed uniformly across the site, at a single point in time (e.g., instantaneously), therefore, this analysis does not consider the sediment mixing and exchange or ongoing sediment deposition that would occur over the timeframe required to conduct this cleanup. Moreover, this hypothetical scenario may~~would~~ have a construction timeframe of more than 15 years, during which time sediments would be mixing due to vessel propwash. Accordingly, the above site-wide post-construction SWAC represents, in the Port's view, an idealized condition that may~~can~~ not realistically be achieved during remedy implementation.

4.1.2 Maintenance in the Long Term

This section describes three~~four~~ considerations by the Port for whether it would be technically possible to maintain the natural-background based SCOs for total PCBs and dioxin/furan in the long term, considering the lowest technically possible achievable concentration estimated in Section 4.1.1. The three~~four~~ considerations are as follows:

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1. Predicted increase in the SWAC following sediment mixing and exchange between underpier and open-water sediment
2. Predicted future average concentrations in particulate matter entering the EW
3. Measured concentrations present in surface sediment at remediated sites proximal to the EW
4. ~~Measured surface sediment concentrations in Elliott Bay~~

The first line of ~~evidence~~consideration is the box model site-wide SWAC predictions. Following construction, box model predictions of the site-wide SWAC for each of the remediation alternatives except no action increase in the short-term (e.g., year 5 following construction) as a result of possible sediment mixing and exchange between open-water and underpier sediments (see FS Appendix J). The box model predicts that concentrations will then gradually reduce toward the net incoming sediment concentrations over time, which are estimated to be above natural background-based cleanup levels and lowest technically possible achievable concentration for total PCBs and dioxins/furans (see next line of evidence). As indicated in Appendix J, the box model is based on a series of assumptions which were developed for the purposes of comparing alternatives. The model output was particularly sensitive to certain input parameters including the incoming Green-Duwamish sediment concentrations, bioavailability reductions from carbon treatment, and net sedimentation rates, all of which are highly uncertain.

The second line of ~~evidence~~consideration is the estimated concentration of incoming sediments. Table 2 provides the estimated average sediment input concentrations for the EW based on incoming solids from both upstream (including Green River and LDW) and EW lateral inputs. These concentrations were calculated using a weighted average of chemical concentrations based on inputs entering the EW from the Green/Duwamish River, resuspended LDW bedded sediment, and lateral inputs from both the LDW and EW (see FS Table 5-5). These estimates do not consider ongoing efforts to reduce sources of contamination to -the upper Duwamish/Green River watershed, and thus are likely- biased high. Average input concentrations do not incorporate concentrations that may come from the EW bed, including the dredge residuals that will be present following construction, and sediments in unremediated areas. Average input concentrations were developed for the base case (best estimate), low bounding, and high bounding runs, adjusted to account for

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additional source control for lateral inputs (i.e., combined sewer overflow [CSO] and stormwater inputs) managed by source control programs (e.g., National Pollutant Discharge Elimination System [NPDES]). For total PCBs, the average input concentrations ranged from 85 to 8580 μg/kg dw, and for dioxin/furans the average input concentrations ranged from 2 to 8 ng TEQ/kg dw. The base case (best estimates) values for both total PCBs (4542 μg/kg dw) and dioxins/furans (6 ng TEQ/kg dw) are well above the SCO concentrations for total PCBs (23 μg/kg dw), and marginally above the SCO for dioxins/furans (25 ng TEQ/kg dw). NPDES permit conditions may be modified in the future to reduce COC inputs to the EW.

Commented [A5]: According to Table 5-5.

The third line of ~~evidence~~consideration is the post-remediation surface sediment concentrations of four cleanup sites in relatively close proximity to the EW, which were selected as representative of the post-remediation concentrations that could be expected to be achieved in the long term. Table 2 summarizes ~~the most recent available~~ post-remediation monitoring data as of (insert date of most recent sampling data used for this analysis) for Pier 53-54, Lockheed Shipyard, Todd Shipyards, and Duwamish Diagonal, as well as the form of remediation (dredging, capping, or ENR) used at each site. The surface sediment data range from 5 to 10 years post-remediation and represent the surface sediment concentrations that can be expected following dredging, capping, or ENR, as well as the influence of ongoing sedimentation from diffuse urban inputs. Mean concentrations from the above four datasets suggest that post-remediation concentrations in the EW could range from approximately 32 to 133 μg/kg dw for total PCBs, and be approximately 5 ng TEQ/kg dw for dioxin/furans (data from Duwamish/Diagonal cap only), depending on the dataset considered. These concentrations exceed the natural background levels for total PCBs and dioxins/furans. The resultant ranges of concentrations from all four of the datasets suggest that it is not technically possible to maintain the PRG~~SCO~~ for total PCBs (2~~3.5~~ μg/kg dw) and may or may not be possible to maintain the PRG~~SCO~~ for dioxins/furans (2~~5~~ ng TEQ/kg dw) in the long term in this region of Puget Sound, including the EW. It is important to note that these ranges do not incorporate ongoing and future source control efforts or sediment remediation in the surrounding area within the watersheds and may overestimate long-term concentrations. Furthermore the sediment dynamics in the locations represented by these studies differ from those of the EW.

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~~The fourth line of evidence~~consideration ~~is surface sediment concentrations from Elliott Bay. These data represent ambient concentrations in Elliott Bay, which provides an estimate of deposited sediment from diffuse urban inputs that may influence expected long-term concentrations. As shown in Table 2, inner Elliott Bay[5] samples had a mean total PCBs concentration of 153 µg/kg dw (2007 data), and the mean dioxins/furans concentration was 20 ng TEQ/kg dw (2007 data). Concentrations are higher when 90th percentile values are considered (274 µg/kg dw for total PCBs based on 2007 data). In outer Elliott Bay, mean total PCBs concentrations range from 28 µg/kg dw (2007 data) to 32 µg/kg dw (1991 to 2004 data), and the mean dioxins/furans concentration was 2 ng TEQ/kg dw (2007 data) (see Table 2). Concentrations are higher when 90th percentile values are considered (e.g., 53 µg/kg dw for total PCBs based on 2007 data). Post-remediation concentrations of total PCBs and dioxins/furans in sediment in the EW would be higher than these values because of its closer proximity to diffuse urban inputs, which are more represented by data from inner Elliott Bay.~~

Commented [A6]: Although these data appear in the LDW FS, they are taken out of context and were used for an entirely different purpose at LDW. For LDW, these data appear along with average PCB concentrations in other urban bays to provide information on general urban bay PCB concentrations at the time of the LDW FS was written. It was presented for informational purposes only and was not used in any way to support decision-making at LDW. It is inappropriately used here.

In summary, ~~all~~ the three~~four~~ lines of ~~evidence~~ consideration developed and analyzed by the Port to determine concentrations that can be achieved in the long term in the EW indicate that the PRG~~SCO~~ will not likely be achieved or maintained. For total PCBs, the average concentrations are ~~well~~ above the PRG~~SCO~~ of 2~~3.5~~ µg/kg dw, and range of achievable concentrations for all lines of ~~evidence~~consideration is 9 to 153 µg/kg dw. For dioxins/furans, the average concentrations are ~~well~~ above the PRG~~SCO~~ of 2~~5.0~~ ng TEQ/kg dw, and range of achievable concentrations for all lines of ~~evidence~~consideration is 1.7 to 20 ng TEQ/kg dw. However, given that estimates do not include future source control actions in the Green/Duwamish watershed, the resulting values may be biased high. Regional background concentrations, ~~when~~if determined, ~~are expected to~~may fall within this range.

4.2 Net Adverse Environmental Impact

The second factor in determining an upward adjustment of the SCO-based cleanup level is the determination of net adverse impact on the aquatic environment, which takes into account "the short- and long-term positive effects on natural resources, habitat restoration,

[5] ~~Inner Elliott Bay samples are generally defined as samples east of a line from Terminal 91 directly south to West Seattle. Outer Elliott Bay includes the samples west of the line. See the depiction in Appendix J, Figure J-3, of the LDW FS (AECOM 2012).~~

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and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions" (WAC 173-204-560(2)(a)(ii)(B)). This discussion represents some hypothetical future scenarios and possible lines of consideration that could be used as part of a net environmental impacts analysis. It is presented by the Port for comparison purposes only. EPA disagrees with the assumptions made in this analysis and it is not required to be used for EPA decision-making.

The SMS cleanup levels for total PCBs and dioxin/furans that are not adjusted significantly upward from the PRG~~SCO~~ could only be met and reliably maintained with additional dredging over larger areas and at greater depths, and repeated capping and redredging of the same areas as concentrations rise due to diffuse source inputs over time. This approach c~~w~~ould result in very large adverse impacts on the aquatic environment (natural resources and habitat) from construction without producing any countervailing long-term environmental benefits from the additional cleanup measures (i.e., risk reduction). Repeated rounds of dredging and/or capping would result in major additional construction-related adverse impacts to the benthic community, due to disruption of the established biological active zone, and to fish tissue contaminant levels, due to releases of contaminated material during dredging, resulting in higher fish exposures. In addition, these adverse impacts would occur over a significantly longer period of time. Even with ongoing efforts of this type, evidence presented in Section 4.1 of this appendix suggests that the PRGs~~SCOs~~ for total PCBs and dioxin/furans would still not be achieved. As such, the continued cleanup activities in an attempt to reach concentrations closer to the PRG~~SCO~~ would result in significant adverse impacts to the environment without commensurate benefits to the benthic community or reductions in tissue concentrations that would lower human health risks. Ultimately, the EW system will equilibrate to incoming sediment concentrations that are estimated to be higher than the PRG~~SCO~~ and similar to concentrations resulting from less disruptive cleanup activities associated with higher cleanup levels (e.g., CSL).

In comparison, the SMS cleanup levels based on the CSL for total PCBs and dioxin/furans (i.e., regional background, ~~once~~if established) would result in slightly smaller adverse impacts on the aquatic environment from construction because the cleanup technologies needed to meet the cleanup levels would be less intrusive to benthic communities in some areas (less dredging or capping), and the need for additional contingency actions would be

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greatly reduced or eliminated. A cleanup level at or close to ~~the~~a potential regional background for total PCBs and dioxin/furans, ~~once~~if established, would reflect the concentrations of those contaminants in incoming sediment over the long term, thereby avoiding unnecessary adverse impacts on the aquatic environment from construction and ultimately resulting in similar or improved long-term environmental benefits from cleanup (i.e., risk-reduction). Therefore, sediment cleanup levels based on PRG~~SCO~~ will result in net adverse impacts, which would likely not occur with cleanup levels that are adjusted upward to the CSL based on regional background.

4.3 Summary and Conclusion

This Port analysis indicates that ~~C~~compliance with the SMS and CERCLA PRGs would~~ill~~ ~~require~~likely involve the adjustment of cleanup levels upward from the PRGs ~~SCO~~ to the CSL for total PCBs and dioxins/furans. This adjustment ~~will~~may occur in the future ~~when~~if the CSL (i.e., a regional background value suitable for use at the EW Superfund site) is established by EPA for these contaminants.

For FS purposes, a hypothetical maximum removal scenario was analyzed to approximate lowest technically possible concentrations for total PCBs that could be achieved following construction. This analysis by the Port indicated that approximately 57 µg/kg dw could be achieved (34 µg/kg when making adjustments for bioavailability) when considering limitations to remediating near structures to achieve very low total PCBs concentrations.

Multiple lines of ~~evidence~~consideration were analyzed by the Port to approximate values that could be achieved in the long term. For total PCBs, the average concentrations are ~~well~~ above the ~~SCO~~PRG of 2~~3.5~~ µg/kg dw, and range of achievable concentrations for all lines of evidence is 9 to 153 µg/kg dw. For dioxins/furans, the average concentrations are above the ~~SCO~~PRG of ~~5.0~~2 ng TEQ/kg dw, and range of achievable concentrations for all lines of ~~evidence~~consideration is 1.7 to 20 ng TEQ/kg dw. As discussed in Section 4, under the SMS, the cleanup level may not be adjusted above the CSL (i.e., regional background values, ~~once~~if established by EPA).

Finally, a possible scenario for considering the net adverse environmental impact for setting the cleanup level at the SCO was qualitatively discussed by the Port, indicating that the

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cleanup levels would likely need to be adjusted upward to the CSL, ~~when~~if established, to avoid environmental disturbances that results in no environmental benefit.

As noted above, this analysis was developed by the Port for FS purposes only; it contains numerous assumptions about future conditions that cannot be reliably estimated at this time. It is not required to be used for EPA decision-making, including establishing PRGs or cleanup levels. Technical possibility will be determined based on empirical long-term monitoring data for the selected alternative to comply with the SMS.

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5 SEDIMENT RECOVERY ZONE

Under the SMS, an Ecology-approved restoration timeframe of longer than 10 years (i.e., cleanup levels not achieved within 10 years) would result in the designation of an SRZ (WAC 173-204-570(5)(b)). The SMS define the SRZ as the following:

> *"Sediment recovery zone" means an area authorized by the department within a site or sediment cleanup unit where the department has determined the cleanup action cannot achieve the applicable sediment cleanup standards within ten years after completion of construction of the active components of the cleanup action.*

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Designation of an SRZ is accomplished through a process administered by Ecology. An absolute restoration timeframe of 10 years or more as Ecology would establish under the SRZ provisions of the SMS is not necessarily more stringent than CERCLA requirements, thus, an SRZ is not an ARAR under CERCLA. EPA may consider the substantive criteria for an SRZ, WAC 173-204-590(3), when determining the length of time for completion of the remedial action for the EW. The remaining portion of the discussion of SRZs under the SMS is presented by the Port for comparison purposes only and has no bearing on EPA decision-making for the EW.

The SRZ is used to track a cleanup area that remains above cleanup levels and perform additional cleanup or source control actions as necessary. The requirements of the SRZ are listed in WAC 173-204-590(2), are very similar to the CERCLA requirements of the selected remedy~~, and would be substantively met through CERCLA components of the remedy (e.g., the long-term monitoring and 5-year review framework, and the alternative analysis, comparison, and selection process)~~.

The key components of the SRZ approach~~, if used,~~ are the following:

- The SRZ c~~w~~ould be designated side-wide for relevant human health risk drivers 10 years following construction.
- ~~The Harbor Island Superfund Site~~ 5-year reviews and site-wide monitoring program ~~w~~could provide the periodic review process for adjusting, eliminating, or renewing the SRZ consistent with the SMS.

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- The SRZ ~~w~~could be used in concert with active cleanup and source control measures for the selected alternative, and would not replace cleanup actions. The contaminant concentrations within the SRZ will be as close as practicable to the cleanup level, based on the CERCLA comparison of alternatives under the nine criteria in the FS.

~~For the EW, p~~Post-construction site-wide monitoring data ~~would~~may be used to evaluate progress toward meeting the cleanup levels. This information could also be used to support establishment or evaluation of regional background concentrations and potential modification of the SRZ and closure of the site.

> *If monitoring data shows cleanup standards cannot be met, the following options are available for Ecology to consider:*
>
> 1. *If noncompliance is due to PLP sources not being controlled, additional source control may be necessary.*
> 2. *If noncompliance is due to contribution from other sources that are not under the responsibility or authority of the PLP, closure of the SRZ may be appropriate or adjustment of the cleanup level may be appropriate. For example:*
>   a. *Ecology may consider whether the cleanup level should be adjusted upwards according to the process detailed in Chapter 7, Section 7.2.3. An example of when this may be appropriate is where the cleanup level was established below regional background, but Ecology has since established or approved regional background for the geographic area where the site is located. In this case, Ecology may determine that regional background represents the concentration in sediment that is technically possible to maintain, due to ongoing sources that are not under the authority or responsibility of the PLP. Therefore, Ecology could allow upwards adjustment of the sediment cleanup level to the CSL if regional background has been established as the CSL.*
>   b. *If the cleanup levels are based on background (regional or natural), Ecology will consider whether background concentrations have increased and the cleanup level should be adjusted upwards.*
>
> (Ecology 2017, Section 14.2.6)

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6 CONCLUSIONS

The PRGs in the EW FS have been developed under CERCLA to be consistent with the SMS (WAC 173-204-560). The selected alternative will meet the SMS ARAR over time by achieving the SCO, or by achieving the cleanup level after the establishment of a CSL and upward adjustment of the cleanup level. If cleanup levels are not achieved ~~within 10 years~~ following construction, additional time for achieving the cleanup levels may be warranted under CERCLA if determined to be appropriate by EPA. In that instance, the substantive ~~requirements~~criteria of an SRZ (WAC 173-204-590(3)) ~~will~~could be ~~met through the CERCLA 5-year review process~~considered by EPA.

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Because it is not known whether, or to what extent, the SMS ARARs for various COCs will be achieved in the long term, or the timing of a potential regional background evaluation, ~~the~~it is not possible to definitively determine SMS compliance ~~mechanism is not selected~~ at this time. The method used to comply with the SMS ARAR will depend primarily on the timing of regional background evaluations for the EW and measured site performance following construction.

EPA may also issue a TI waiver at some point in the future if EPA determines that the SMS-based cleanup levels cannot be practicably achieved within the EW based on long-term monitoring data and trends. This would be conducted either as part of a ROD Amendment or an ESD.

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TABLES

FIGURES